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Description

This invention relates to cartridge filters for use in filter systems designed to remove solid particles or dust from large volumes of gases, including air, in which they are suspended, such as industrial sweepers, bag houses, plenum type dust collectors, and the like. These systems rely on a plurality of filter devices which embody a porous filter material through which the gaseous medium passes, the solids being retained on the upstream surface of the filter medium as the gases pass through. The separated solids build up on the upstream side of the filter medium with time and must be removed before the thickness of the accumulated solids layer causes excessive pressure drop. In current practice, the filter cake can be dislodged from the filter elements by means of a pulse of compressed air admitted to the filter element, a reverse air flow, or a shaker mechanism. The filter medium flexes under the force of the air pulse to dislodge the filter cake and the flow of gases being filtered is maintained while such flexing and dislodging is taking place.

It is known from US-A-2,907,408 to provide a gas filter cartridge comprising a pleated filter medium and a support on which the filter medium is supported, the support comprising a first plurality of wire stays which lie within and support the one set of alternate apices of the pleats of the filter medium, a second plurality of wire stays which lie within and support the other set of alternate apices of the pleats of the filter medium, and two opposite end supports in which the ends of the stays are anchored. In this prior art disclosure separate V-shaped wire support frames are provided for supporting the panels of the pleated filter material and the wire stays are light support bars optionally disposed in the apices of the pleats.

In US-A-3,853,509 wire frames are arranged in spaced-apart relationship to permit a filter bag to be removably contained in a pleated form between the frames.

In DE-B-2,417,551 a pleated filter construction is described which is located between end caps.

The present invention seeks to provide a unitary filter construction which is relatively simple to manufacture and in which the filter element is securely and permanently supported between wire supports and sealed between end caps.

According to the present invention there is provided a gas filter cartridge comprising a pleated filter medium and a support on which the filter medium is supported, the support comprising a first plurality of wire stays which lie within and support the one set of alternate apices of the pleats of the filter medium, a second plurality of wire stays which lie within and support the other set of alternate apices of the pleats of the filter medium, and two opposite end supports in which the ends of the stays are anchored characterised in that the filter is cylindrical, the first plurality of wire stays which support the radially outer apices are secured together to form a pleated wire

support frame, the second plurality of wire stays are bent at their opposite ends to engage the wire frame so that the filter medium is supported wholly between the wire stays and the wire frame, and the end supports are caps which are secured to the wire frame and the wire stays by encapsulating or embedding medium.

The inner wire frame is formed of wires of suitable size, strength, stiffness, corrosion resistance, and other properties, the wires being spaced apart at predetermined intervals and bent into a generally cylindrical shape having a pleated or folded configuration around the cylindrical axis.

A sheet of filter medium of the same length as the inner wire frame is folded or pleated to conform with the folds of the frame and formed into a pleated cylindrical filter supported by the frame. Filter media well known in the art for filtering particles from gas may be used as the filter medium. Woven and non-woven textile fabrics, mats, and felts of natural, synthetic organic, glass, or metal fibrous materials may be used as well as porous polymeric films, sheets, and foams. Composite sheets or films of one or more of the above materials can be used to provide an appropriate porosity to remove particles from the gas and/or to provide strength to resist the filtration pressure of the gas stream and/or the gas pressure of a pulse jet cleaning mechanism or method. The preferred filter material for use in this invention is a composite sheet of porous expanded polytetrafluoroethylene film bonded to a woven or felt textile backing material. The porous expanded polytetrafluoroethylene film is prepared in accordance with one or more of Gore U.S. patents 4,187,390; 4,110,392; 4,096,227; 3,962,153; 3,953,566 and 4,025,679. The non-sticking properties of the polytetrafluoroethylene surfaces of such composites minimize the sticking and consequent build-up of particles being filtered from the gas stream to the filter and also facilitate periodic removal of any filter cake build-up by pulse jet or other cleaning method.

The filter medium is supported against the inner pleated wire frame by wire stays attached at each end to the frame wires and disposed each in an inner apex of a pleat on the outside of the filter medium. Each end of the outer support wire stay is bent into a shape such that it may be hooked across top or bottom wires of the inner support frame to hold the longitudinal portion of the wire stay firmly in place in the apex of the pleat of the filter medium. Each outer support wire stay is also bent into an initial inwardly curved shape, preferably paraboloidal, such that when one end of the stay wire is attached to the inner wire frame, and the wire stay pressed into the apex of a pleat of the filter medium, and the other end of the stay hooked over a wire at the other end of the inner wire frame, then the spring tension in the wire stay will cause it to press firmly into the apex of the pleat of the filter medium and hold it firmly in place against air pressure impinging on the back side of the filter medium from a pulse jet cleaning

apparatus or the like. The use of the bent wire outer support stays is advantageous in that it not only holds the filter medium firmly to the inner wire frame, but no protuberances, bulges, or ledges are present to catch and hold dust against the active filter area. Also, less wire is required than for many other wire support methods known in the art. An alternative form of outer support stay to the bent wire stay is a slightly inwardly bowed stay prepared by rolling or bending flat metal sheeting into a U-shaped or V-shaped or other appropriately shaped cross-section, with the ends left flat for easy attachment to the wires of the inner frame. Further, bent U-shaped or V-shaped stay wires without the flat ends may be bent and held in place by bent round (or other shaped) stay wires placed in the outer grooved side of the stays and the ends of the round wires hooked over the inner support frame wires to hold the combination in place.

The assembled pleated inner support frame, pleated filter medium, and outer support wire stays can then be sealed to end caps by embedding in rubber, thermoplastic resin plastisol, or the like. A preferable embodiment for a lower end cap, where minimum accumulation of particles on the protuberances of the filter assembly would occur, would consist of a contoured end cap with the contour following or approximating in shape to that of the pleats in the filter medium and inner wire support frame. Each end cap can be a metal or plastic cap or the molded thermoplastic resin plastisol and its embedded components can serve as the lower end cap. This can be made by embedding or potting the lower end of the filter assembly in the requisite potting material, letting it harden sufficiently to hold its shape, removing the mold, and allowing the potting material to continue to cure to a hard completely cured end cap.

The invention will now be particularly described, by way of example, with reference to the accompanying drawings in which:-

Fig. 1 is an exploded perspective diagram of the cartridge filter according to the invention, showing part of the pleated filter medium cut away in the pleats of the inner support wire frame, and two alternative forms of lower end cap;

Fig. 2 is a perspective view illustrating the attachment of the outer support stays to the inner frame, the filter medium cut away to show the pleated inner frame, and a sealed or potted lower end of the cartridge;

Fig. 3 is a perspective view illustrating the attachment of an alternative outer support stay of V-shaped or U-shaped cross-section to the inner support frame;

Fig. 4 is a schematic drawing of an outer support wire stay in both bent (before attachment) and straight (after assembly to cartridge) configurations;

Fig. 5 is a schematic drawing of an alternative outer support stay of V-shaped or U-shaped cross-section, and Fig. 4a and Fig. 5a are respective cross-sections of the stays shown in Fig. 4 and Fig. 5.

The filter cartridge, in the embodiment of the

invention shown in Fig. 1, is simply constructed in cylindrical form from a gasketed top end cap, a pleated inner wire support frame for the pleated filter medium, outer support stay wires, and a lower end cap. The top end cap 2 is formed of thin steel, galvanized steel, stainless steel, or aluminium sheet, molded plastic or other materials, and may be stamped, spun, turned, molded, or cast. 24 gauge stamped galvanized steel is a preferred material. A gasket 1 of rubber or polyurethane is affixed to the top cap 2 to aid in sealing the cartridge to its mounting means and may be of molded, cast, or strip material. Neoprene (E.I. duPont de Nemours, Inc. trademark) foam rubber is a preferred gasket material. The filter-medium support frame 3 may be of welded wire mesh or woven or non-woven screen of steel, stainless steel, galvanized steel, aluminium, or plastic. A preferred embodiment utilizes 14 gauge welded wire mesh galvanized steel of 1" x 2" (2.4 cms x 4.8 cms) or 1" x 3 1/4" (2.4 cms x 7.8 cms) mesh spacing.

The pleated filter medium 4 is formed from woven or non-woven fabric or felt used either alone or in combination with a porous membrane. The fabric or felt may be of natural or synthetic fibres, organic polymers, metal, for example, and of a porosity and composition appropriate for the size of particles being filtered from the gas stream and the temperature, corrosiveness, and other conditions to be encountered in filtration. Preferred filter media are laminates of porous expanded polytetrafluoroethylene membrane with polyester, conductive polyester, polypropylene, polyaramide, fiberglass, and polytetrafluoroethylene felts and fabrics. The porous expanded polytetrafluoroethylene membranes, felts, and fibres are described in the above references and these and the other preferred felts and fabric are obtained as well-known commercially available materials.

The outside stay wires 5 may be drawn wire of 5 to 12 gauge steel, stainless steel, or galvanized steel and are formed preferably in a paraboloid curve so that when one end is hooked to the support frame, the wire pressed into the apex of a fold in the filter medium, and the other end hooked over the other end of the support frame, the tension of the straightened bow in the wire will hold the filter medium in place against air pressure from a jet pulse cleaning device. A preferred example of suitable wire is 9-gauge galvanized steel wire of 65,000 100,000 psi (44,800 68,900 kPa) tensile strength. Wire of high tensile strength such as 250,000 psi (172,400 kPa) or above specification may also be used.

Lower end caps 6 and 7 are made from the same materials as and formed similarly to the top end cap. Contoured end cap 7 is particularly suitable for use to avoid build up of dust ledges or piles at the bottom of the cartridge. A molded cap 6 or contoured cap 7 may consist solely of hardened encapsulating or potting material formed or molded about the bottom of the support frame, filter medium, and stay wires to effect a bottom

seal and closure to the cartridge. A pre-shaped mold would be filled with encapsulating or potting material of the proper consistency or softness, the assembled cartridge components to be capped pressed into or embedded in the mold, the encapsulating material allowed to cure or harden sufficiently to be self-supporting, the outer mold removed, and the molded bottom end cap allowed to cure or harden completely.

Fig. 2 shows how the outer stay wires 5 hook over the wires of the inner frame 3, and gives details of the inner support frame 3 and the embedding of the support frame 3, the filter medium 4, and the outer stay wires 5 in bottom end cap 6.

Fig. 3 details the attachment of the outer stay wires 8 in the alternative V-shaped or U-shaped cross-section to the inner wire support frame 3 by folding the flat ends over the wire's inner frame 3 by mechanical means.

Fig. 4 depicts the shape and end detail of outer stay wire 5.

Fig. 5 details the alternative form of outer stay wire 8 of V-shaped or U-shaped cross-section. This is formed by bending strips of flat steel to a cross-sectional shape over a mandrel, leaving the ends in flat tab form for subsequent bending over the inner support frame wires for attachment during assembly of the cartridge. The strip is then rolled to a slight bow configuration to provide the springiness needed to exert pressure into the apex of a fold of the filter medium as shown above. It is intended that the term outer support wire or stay wire should include wire of any cross-section which, when in its initially bent form it is straightened into an inner apex of an outer fold of the filter medium and attached at its ends to the wires of the inner frame, will exert pressure on the filter medium to hold it in place and resist the pressure exerted against the filter medium from the interior of the filter cartridge by the forces exerted on it by a pulse jet cleaning device. The stay wire should not, however, have such a shape or cross-section that edges would cause wear or damage to the filter medium from pressure, friction or puncture.

An optional variation of the method of using the stay wires to further hold the stay wires firmly to the filter medium and inner wire frame in this invention is adhesive. The longitudinal portion of the stay wires may be coated with an adhesive on the surface of the wire intended to face the filter medium. A commercial grade of either solvent-based urethane or hot-melt polyester adhesive could be used as well as others which will adhere to both the stay wires and to the outer surface of the filter medium being used.

Where exceptional outer stay wire rigidity is desired, a round stay wire is placed in the groove of a U-shaped or V-shaped stay wire, which has been manufactured without the flat ends for subsequent attachment purposes, and the combination of stay wires pressed into an inner pleat of the filter medium, where it is held by hooking the round wire over the wires of the inner support

frame in the usual manner. Stay wires of cross-section other than round or circular may be used. The U-shaped or V-shaped stay wire is held firmly in place by the other stay wire and does not ordinarily require other attachment.

The preferred way of sealing the inner support frame, filter medium, and outer support stays into the end caps is by embedding or potting each end in a matrix of urethane, epoxy, or silicone rubber or in a thermoplastic resin plastisol or other suitable thermoplastic resin. The preferred material is a commercial 2-component polyurethane resin system, such as the PN: DRZ 27141 system available from Isocyanate Corporation.

The filtration cartridge of the invention has a number of advantages over many of the cartridges known in the art. The filter medium is supported by a formed wire support frame which prevents the medium from collapsing under pressure and dust loading. The frame also prevents the inside and the outside of the pleats of the pleated filter medium from closing off and thus reducing air flow through the filter cartridge. The use of outer spring stay wires with the inner support frame also keeps the filter medium open by pressing the medium firmly to the wire support frame and prevents the collapse of the pleats to the outside when the filter medium is cleaned from the inside by a high energy air pulse jet. The straight outer stay wire eliminates ledges which allow dust build-up and reduce air flow through the filter cartridge. The alternative form of contoured bottom/lower end cap, the outer periphery of which is shaped to correspond to the pleats of the filter medium and inner wire support frame, also helps to eliminate ledges for dust build-up and the resultant reduction of air flow.

Claims

1. A gas filter cartridge comprising a pleated filter medium and a support on which the filter medium is supported, the support comprising a first plurality of wire stays which lie within and support the one set of alternate apices of the pleats of the filter medium, a second plurality of wire stays which lie within and support the other set of alternate apices of the pleats of the filter medium, and two opposite end supports in which the ends of the stays are anchored characterised in that the filter is cylindrical, the first plurality of wire stays which support the radially outer apices are secured together to form a pleated wire support frame (3), the second plurality of wire stays (5) are bent at their opposite ends to engage the wire frame (3) so that the filter medium (4) is supported wholly between the wire stays 5 and the wire frame 3, and the end supports are caps which are secured to the wire frame and the wire stays by encapsulating or embedding medium.

2. A cartridge according to claim 1, characterised in that the said wire stays (5) are formed from inwardly curved wires.

3. A cartridge according to claim 2, characterised in that the periphery of the lower end cap

(7) has the same contour as the lower end of said pleated filter medium (4) and of said pleated wire support frame (3).

4. A cartridge according to claim 3 characterised in that the mechanically fastened outer stay wires (5 or 8) are adhered to said filter medium (4) along their length.

5. A cartridge according to any preceding claim, characterised in that the said pleated filter medium (4) comprises at least one layer of porous expanded polytetrafluoroethylene.

Patentansprüche

1. Gasfilterpatrone mit einem Faltenfiltermedium und einer Halterung, an der das Filtermedium gehalten ist, wobei die Halterung eine erste Mehrzahl von Drahtstreben, die innerhalb der einen Gruppe von abwechselnden Bugkanten der Falten des Filtermediums liegen und sie stützen, eine zweite Mehrzahl von Drahtstreben, die innerhalb der anderen Gruppe von abwechselnden Bugkanten der Falten des Filtermediums liegen und sie stützen, und zwei gegenüberliegende Endhalter aufweist, in denen die Enden der Streben verankert sind, dadurch gekennzeichnet, daß das Filter zylindrisch ist, die erste Mehrzahl von Drahtstreben, die die radial äußeren Bugkanten stützen, miteinander verbunden sind, um einen Faltendrahtstützrahmen (3) zu bilden, die zweite Mehrzahl von Drahtstreben (5) an ihren gegenüberliegenden Enden umgebogen sind, um mit dem Drahtrahmen (3) in Eingriff zu gelangen, so daß das Filtermedium (4) zur Gänze zwischen den Drahtstreben (5) und dem Drahtrahmen (3) gehalten ist, und die Endhalter Kappen sind, die am Drahtrahmen und an den Drahtstreben durch Einkapseloder Einbettungsmedium befestigt sind.

2. Patrone nach Anspruch 1, dadurch gekennzeichnet, daß die Drahtstreben (5) aus einwärts gekrümmten Drähten gebildet sind.

3. Patrone nach Anspruch 2, dadurch gekennzeichnet, daß der Umfang der unteren Endkappe (7) die gleiche Kontur wie das untere Ende des Faltenfiltermediums (4) und des Faltendrahtstützrahmens (3) hat.

4. Patrone nach Anspruch 3, dadurch gekennzeichnet, daß die mechanisch befestigten äußeren Strebendrähte (5 oder 8) auf ihrer Länge am Filtermedium (4) angeklebt sind.

5. Patrone nach einem beliebigen vorhergehenden Anspruch, dadurch gekennzeichnet, daß das Faltenfiltermedium (4) zumindest eine Schicht aus porösem Polytetrafluoräthylen-Schaumstoff aufweist.

Revendications

1. Cartouche filtrante à gaz comprenant un élément filtrant plissé et un support sur lequel l'élément filtrant est supporté, le support comprenant une première série d'appuis en fil métallique qui se situent dans et supportent la première série de sommets alternés des plis de l'élément filtrant, une seconde série d'appuis en fil métallique qui se situent dans et supportent l'autre série de sommets alternés des plis de l'élément filtrant, ainsi que deux supports d'extrémités opposées dans lesquels les extrémités des appuis sont fixées, caractérisée en ce que le filtre est cylindrique, la première série d'appuis en fil métallique qui supportent les sommets radialement extérieurs sont fixés ensemble pour former un cadre de support en fil métallique plissé (3), la seconde série d'appuis en fil métallique (5) sont courbés à leurs extrémités opposées pour engager le cadre en fil métallique (3) de telle sorte que l'élément filtrant (4) soit supporté entièrement entre les appuis en fil métallique (5) et le cadre en fil métallique (3), et les supports d'extrémité sont des capsules qui sont fixées au cadre en fil métallique et aux appuis en fil métallique par un milieu d'encapsulation ou d'incorporation.

2. Cartouche suivant la revendication 1, caractérisée en ce que les appuis en fil métallique (5) sont formés à partir de fils métalliques incurvés vers l'intérieur.

3. Cartouche suivant la revendication 2, caractérisée en ce que la périphérie de la capsule d'extrémité inférieure (7) a le même contour que l'extrémité inférieure de l'élément filtrant plissé (4) et du cadre de support en fil métallique plissé (3).

4. Cartouche suivant la revendication 3, caractérisée en ce que les fils métalliques d'appui extérieurs fixés mécaniquement (5 ou 8) adhèrent à l'élément filtrant (4) suivant leur longueur.

5. Cartouche suivant l'une quelconque des revendications précédentes, caractérisée en ce que l'élément filtrant plissé (4) comprend au moins une couche de polytétrafluoréthylène expansé poreux.

FIG. 1.

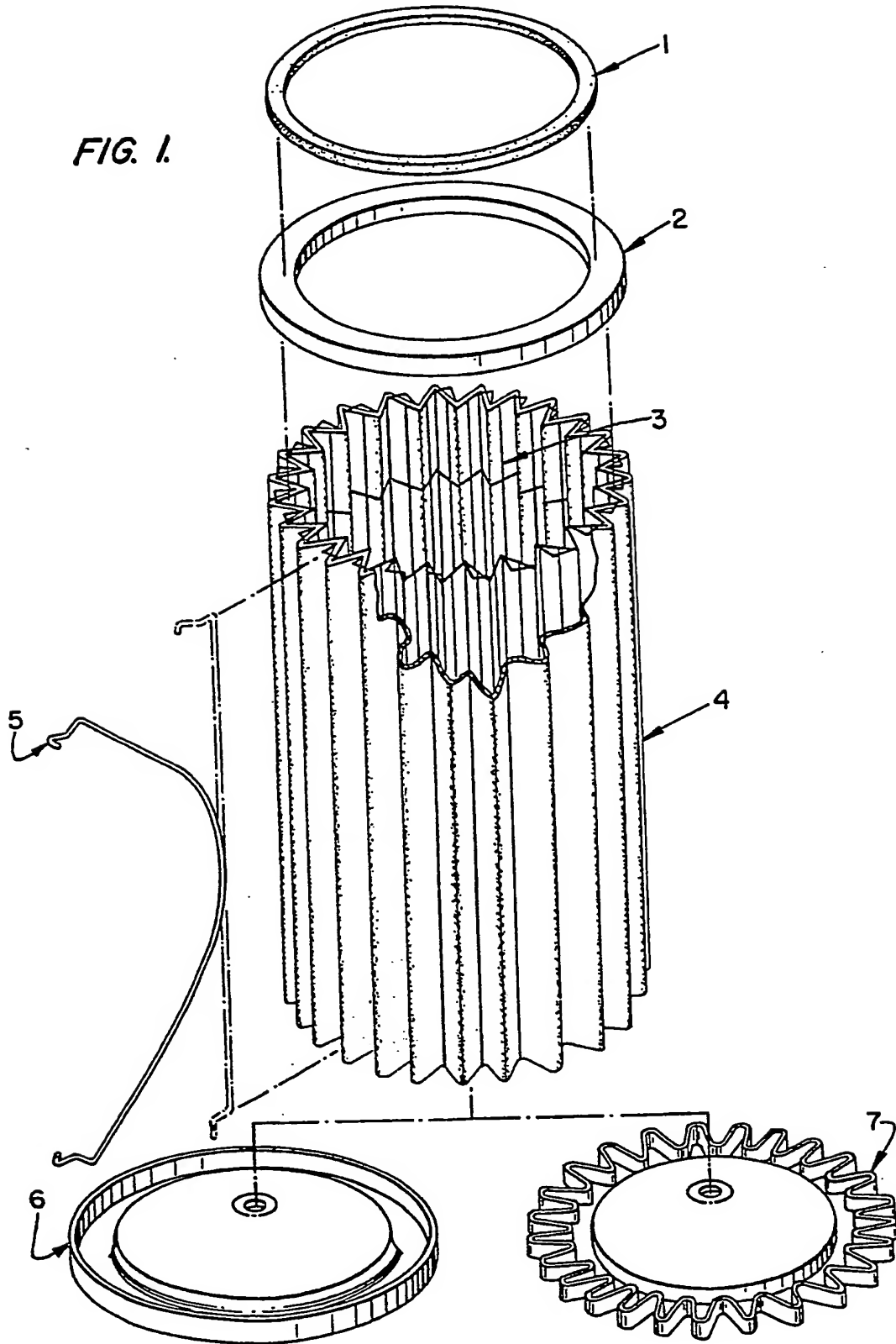


FIG. 2.

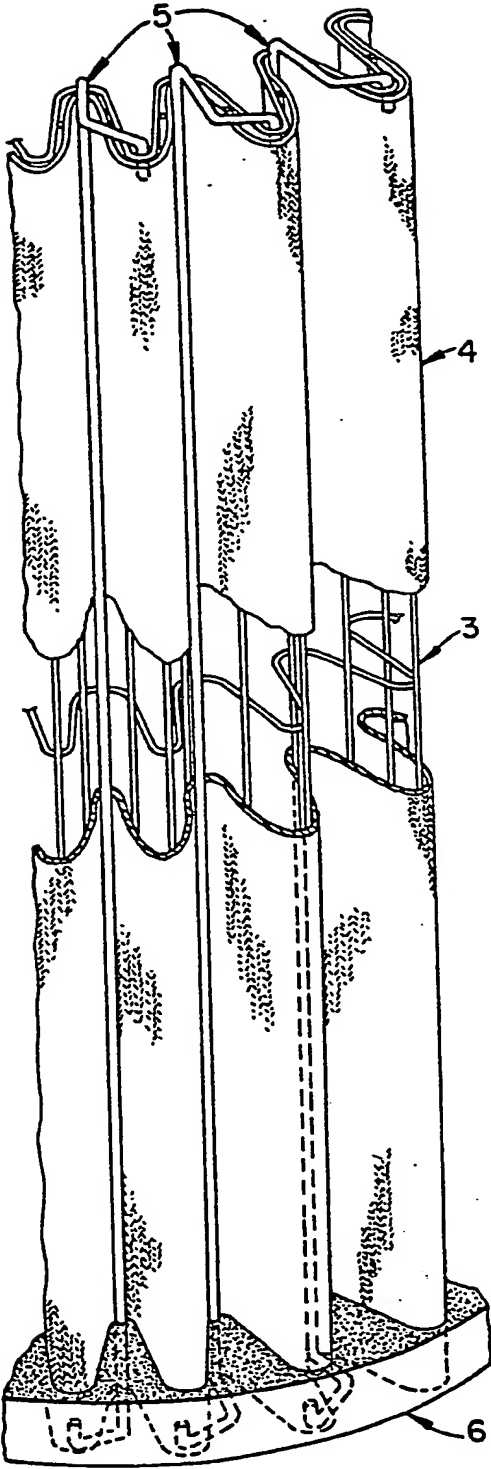


FIG. 3.

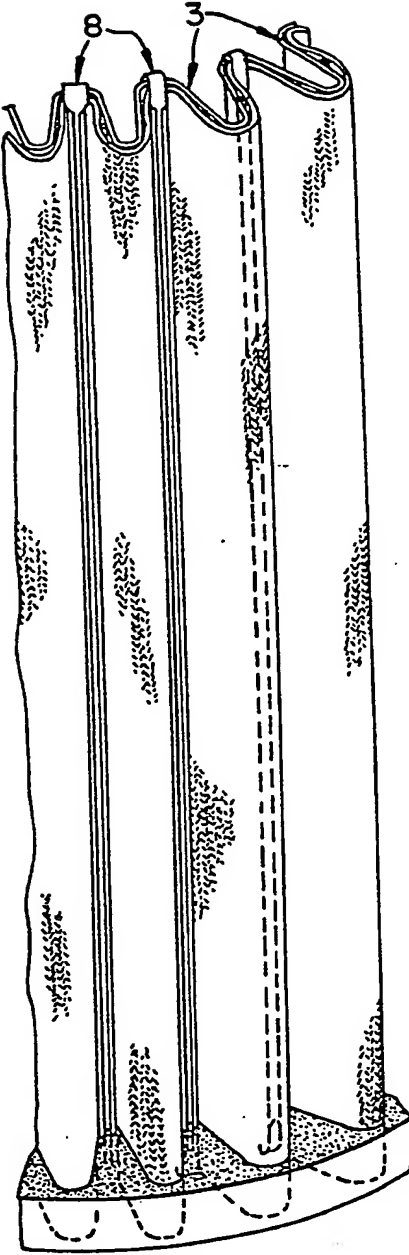


FIG. 5.

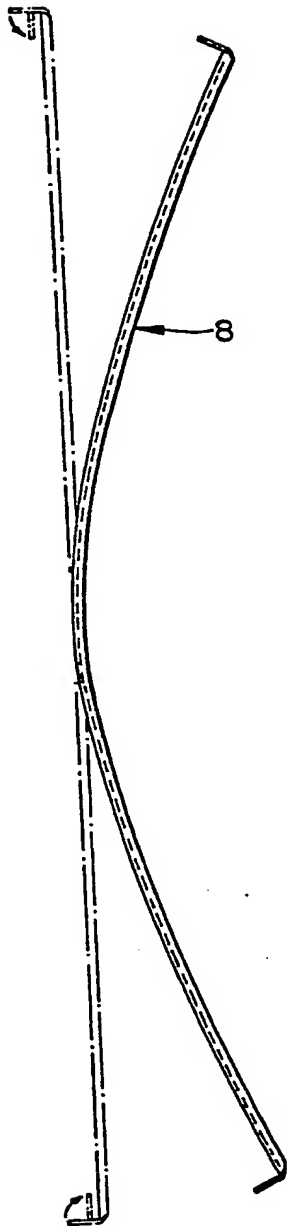


FIG. 5a.



FIG. 4.

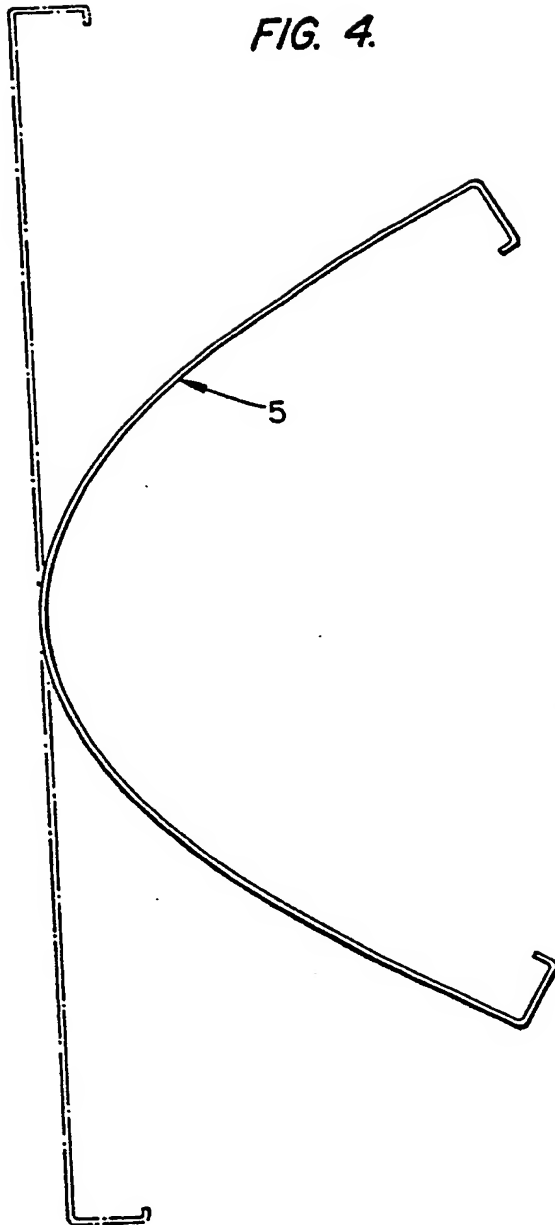


FIG. 4a.

